ANALYSIS OF THE ELECTROCHEMICAL METHOD OF HYDROGEN REALESE USING THE EVANS DIAGRAM

Mykhailo Sukhyi, Volodymyr Nefedov, Yuliya Polishchuk

Educational and scientific institute "Ukrainian State University of Chemical Technology" of Ukrainian State University of Science and Technologies, Dnipro, 49010 Ukraine

Modern industry and energy are increasingly focused on the user of environmentally friendly technologies. Therefore, hydrogen is considered to be an energy carrier that does not increase the carbonization of the atmosphere. To reduce energy consumption when producing hydrogen, we have proposed a method of electrolysis with a soluble anode made of electronegative metals scrap, for example, aluminum. This makes it possible to replace the anodic process of oxygen release in an alkaline medium with a potential of 0.4 V with a spontaneous process of aluminum dissolution (minus 2.3 V).

The rate of aluminum dissolution is controlled by a conjugate process – the release of hydrogen, the over voltage of the release of which on aluminum is quite high. To increase the rate of aluminum dissolution, an additional cathode with low hydrogen release over voltage, short-circuited with an aluminum anode, is used.

The experiments were carried out in sodium hydroxide solutions with a concentration of 0.1; 0.5; 1 and 2 mol/l in a thermostat at temperatures of 20, 30, 40, and 50°C. Electrodes made of aluminum alloy (composition Cu – 3.8-4.9%; Mg – 1.2-1.8%; Mn – 0.3-0.9%, Fe – 0.5%, and the rest – aluminum) and nickel were installed in the form of plates with dimensions of 10x10 mm under a burette to collect the evolved gas. The current strength and density were calculated from the volume of the gas released. During the experiment, the electrode potentials relative to the silver-chloride reference electrode were measured. The nickel cathode was connected to the aluminum anode via an M2020 ammeter, which made it possible to evaluate the current ratio:

$$I_\Sigma = I_{Al} + I_{Ni}$$

The compromise potential of aluminum with hydrogen released was measured experimentally and converted to the hydrogen scale. The current strength was calculated based on the volume of the gas released. The schematic polarization diagram of aluminum dissolution, supplemented with a nickel electrode, is shown in Fig. 1.

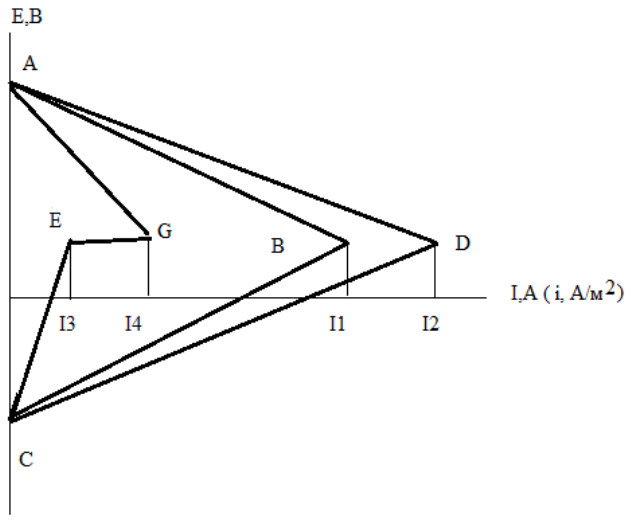

Figure 1 – The schematic polarization diagram of hydrogen release on aluminum and nickel electrodes

Potentials: A – standard potential of aluminum; C – equilibrium potential of hydrogen release; B – measured compromise potential of hydrogen release on aluminum, D – measured potential of an aluminum electrode short-circuited with a nickel electrode; E – measured potential of the nickel electrode; G – measured potential of the aluminum electrode closed with the nickel electrode; ABC – polarization diagram of aluminum dissolution with hydrogen release. The current strength and current density are calculated based on the volume of hydrogen released. ADC – total polarization diagram of hydrogen release on a pair of aluminum + nickel electrodes; AGEC–diagram that takes into account the partial currents of hydrogen release on aluminum and nickel.